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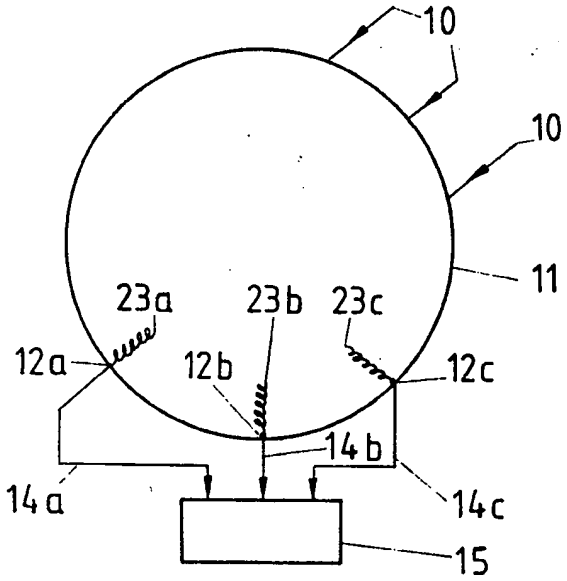

(57) Abstract

The antenna system according to the invention includes a lens (11), which focusses incoming waves (10) at respective focal points (12a-c). Helical feeders (23a-c), which are provided near said focal points (12a-c) and preferably integrated in said lens (11), receive the waves (10) and appropriate signals are led by feeder lines (14a-c) to a suitable receiver (15). By the antenna system according to the invention a mechanical support for the feeders and the feeder lines can be provided. If a hemispherical lens is used, the antenna system is less bulky and especially in this case the length of required feeder lines can be reduced and the receiving efficiency can be increased. The system according to the invention is preferably used as part of a system for receiving Direct Broadcasting Satellite microwaves from different satellites.

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Antenna system

The invention relates to an antenna system including a lens and means for feeding elctromagnetic waves, which can preferably be used for receiving microwave signals.

Antenna systems including a Luneburg lens and appropriate feeds are known, e.g. from US 4 531 129. Such systems can be used as part of a satellite broadcasting receiver system to receive microwave signals. But they can also be used as part of a transmitter system.

It is also known, e.g. from the paper "Virtual Source Luneburg Lenses"; IRE TRANSACTIONS-ANTENNAS AND PROPAGATION, July 1954, pp. 94 - 98, written by G. D. M. Peeler et al., that virtual Luneburg lenses can be used.

Because of the symmetry in the Luneburg lens, plane reflecting surfaces (reflectors) may be placed through its center and the ray paths may be traced by the use of images. The addition of such reflectors produces virtual sources whose positions depend on the orientation of the real feed source and the reflector.

It is generally known, to use antenna systems, which include a parabolic reflector and a feeder horn provided in the focal point of the parabolic reflector, for receiving microwave signals.

From US 4 742 359 it is known, that said feeder horn can be replaced by a helical antenna with two ends whereby the first end is linked to a feeder line. For the purposes of the following explanation it is understood that the said feeder line

is aligned with the axis of the said helical antenna. Such a helical antenna may be built as a so-called endfire helical antenna, where under maximum received power conditions the direction of the signal power flow at the said first end is in the same direction as the received radiation. Such a helical antenna can also be built as a so-called backfire helical antenna, where under maximum received power conditions the direction of the signal power flow at the said first end is in the opposite direction to the received radiation.

In said US patent an antenna system is presented, which comprises a reflector, a primary helical antenna having a coil with a pair of ends, said coil located at the focal point of said reflector so that the axis of the helical antanna coincides essentially with the axis of said reflector. A feeder line couples the antenna system with an external circuit, so that said primary helical antenna represents a backfire helical antenna coupled with said feeder line at the nearer end from said reflector and the other end of the helical antenna is free standing, and said feeder line is a coaxial cable.

It is an object of the present invention to provide a compact antenna system, for receiving several electromagnetical, preferably microwave, signals from different directions.

This is realized by an antenna system according to claim 1.

The antenna system according to the invention includes a lens, preferably a Luneburg-type lens, with feed means shaped as a helical coil.

It is an advantage of the invention that it provides a natural mechanical support for the feed means and feeder cables connected with said feed means.

If a hemispherical lens is used, the production costs may be reduced and the antenna system is less bulky. Especially in this case the inventive antenna system increases receiving efficiency by decreasing aperture blocking and the length of the required feeder cables can be reduced.

It should be mentioned that said feed means, which are also named means for feeding, can be used for receiving and transmitting electromagnetic waves. In the latter case the inventive antenna system can also be used as transmitter antenna system.

The present invention will be better understood by means of the following description and accompanying drawings, wherein

Figs. 1a, 1b	show known antenna systems including a Luneburg-type lens and feeder horns;
Fig. 2	shows a first preferred embodiment of the invention;
Fig. 3	shows a second preferred embodiment of the invention;

Fig 1a shows a known antenna system in which a wave 10 is refracted by a spherical Luneburg lens 11 such that it is focussed in a focal point 12a. Near the focal point 12a a feeder horn 13a is provided, which receives the focussed wave and leads appropriate signals by a coaxial cable 14a to a receiver 15.

Not shown waves may be focussed in focal points 12b, 12c respectively, received by feeder horns 13b, 13c and appropriate signals may be led by coaxial cables 14b, 14c to the receiver 15.

The function of the antenna system according to fig 1a is well known. It may be said, that the receiver 15 is prefera-

bly built as a low noise receiver, which might contain appropriate converting and receiving means.

Fig. 1b shows another known antenna system with a virtual-source Luneburg lens. Details with the same function as in fig. 1a have got the same reference numbers.

The wave 10 is focussed by a construction of a hemispherical Luneburg lens 21 and a plane reflector 16 at a focal point 22a.

The not shown waves may be focussed at focal points 22b, 22c respectively and the according signals are led to the receiver 15.

From the consideration of ray paths, it is evident that perfect virtual images 22a, 22b, 22c of the focal points 12a, 12b, 12c are formed.

It can be seen, that the antenna aperture is blocked by the feeder horns 13a, 13b, 13c and by the coaxial cables 14a, 14b, 14c.

Preferred embodiments according to the invention can be seen in fig. 2 and fig. 3, where details with the same function as in the shown antenna systems are indicated with the same reference numbers and they will only be explained as far as it is necessary for the understanding of the present invention.

In order to simplify the drawing, fig. 2 shows the wave 10 only outside of the spherical Luneburg lens 11. But it is to be kept in mind that said wave 10 propagates also inside said lens 11. At the focal point 12a an endfire helical antenna 23a is provided, which is connected with the coaxial cable 14a.

Near the focal points 12b, 12c endfire helical antennas 23b, 23c are provided and connected with the coaxial cables 14b, 14c respectively.

The signals received by the endfire helical antennas 23a, 23b, 23c are led by the coaxial cables 14a, 14b, 14c to the receiver 15.

Fig. 3 shows another preferred embodiment of the invention, the wave 10 again for clearness being shown only outside of the hemispherical Luneburg lens 21.

At the focal points 22a, 22b, 22c backfire helical antennas 33a, 33b, 33c are provided and coupled with feeder lines 24a, 24b, 24c respectively.

The signals received by the backfire helical antennas 22a, 22b, 22c are led by the feeder lines 24a, 24b, 24c respectively to the receiver 15.

In the preferred embodiments the helical antennas 23, 33 and the feeder lines 24 are integrated in the respective lenses 11, 21. This can be realized by an appropriate production process, where openings may be provided for cable paths and/or the helical antennas 23, 33.

It is another possibility that at least partially the helical antennas and/or the feeder lines 24 are directly surrounded by the material of said lens.

In both cases the refraction index of said lenses may be corrected appropriately, which may be achieved by using a production process, where dielectric material, e.g. shaped as a thread, with a variable refraction index is wrapped. Appropriate corrections of the refraction index are also possible, if dielectric material is formed as a series of hemispherical shells or other suitable shapes.

It is still another possibility to create the cable paths after the manufacture of said lenses by drilling.

It is to be said that versions of the preferred embodiments may contain at least one of the following variations:

- the coaxial cables 14 may be substituted by any other suitable feeder lines, which might be integrated in the lens used;
- more or less than three feeders 23, 33 may be provided;
- the refraction index of the lenses used may have a variation such that the focal points 12, 22 are located inside or outside of the surface of the respective lens 11, 21, whereby the location of the respective feeders 23, 33 may vary appropriately;
- beside the shown feeders 23, 33, which are integrated in the respective lens 11, 21, additional feeders may be arranged outside of the surface of said lens;
- instead of full- or hemi-spherical Luneburg-type lenses, other lenses, e.g. cylindrical Luneburg-type lenses, may be used, whereby an easier arrangement of the feeders 23, 33 and/or a different beamshape may be achieved;
- it is also possible to use a Luneburg-type lense with a conical shape, a pyramid-type shape, or the like. In such a case it is preferred that the shape of the reflector 16, which may be metallic, is varied in such a manner, that it covers at least one of those sides of the lens which are not penetrated by the waves 10 to be received;
- the refraction index of the used lens may vary in such a manner that the receiving of several waves with different frequencies is optimized;
- a homogeneous-type lens may be used, which means that the refraction index may be constant throughout the lens;
- the inventive antenna system may also be used as transmitter antenna system, if the feeder lines 14, 24 are connected to suitable transmitting means.

The antenna system according to the invention includes a lens, which focusses incoming waves at respective focal points. Helical feeders, which are provided near said focal points and preferably integrated in said lens, receive the waves and appropriate signals are led by feeder lines to a suitable receiver or amplifier, or pre-amplifier, or the like.

By the antenna system according to the invention a mechanical support for the feeders and the feeder lines can be achieved.

If a hemisperical lens is used, the antenna system is less bulky and especially in this case the length of required feeder lines can be reduced and the receiving efficiency can be increased compared to known systems.

The system according to the invention is preferably used as part of a system for receiving Direct Broadcasting Satellite microwaves from different satellites.

C_L_A_I_M_S

1. Antenna system including a lens (11; 21) and feed means (23, 33) for receiving and/or transmitting electromagnetic waves, characterized in that said feed means (23, 33) are shaped as helical coil.

2. Antenna system according to claim 1, characterized in that the lens (11, 21) comprises a spherical lens (11), a hemi-spherical lens (21), a conical lens, a pyramid-type lens, or the like.

3. Antenna system according to claim 1 or 2, characterized in that the lens (11, 21) is a Luneburg-type lens or a homogeneous-type lens.

4. Antenna system according to one of the claims 1 to 3, characterized in that said feed means (23, 33) are shaped as endfire helical antennas (23) and/or as backfire (33) helical antennas.

5. Antenna system according to one of the claims 1 to 4, characterized in that said feed means (23, 33) are provided inside or outside of the surface of the lens (11, 21).

FIG.1a

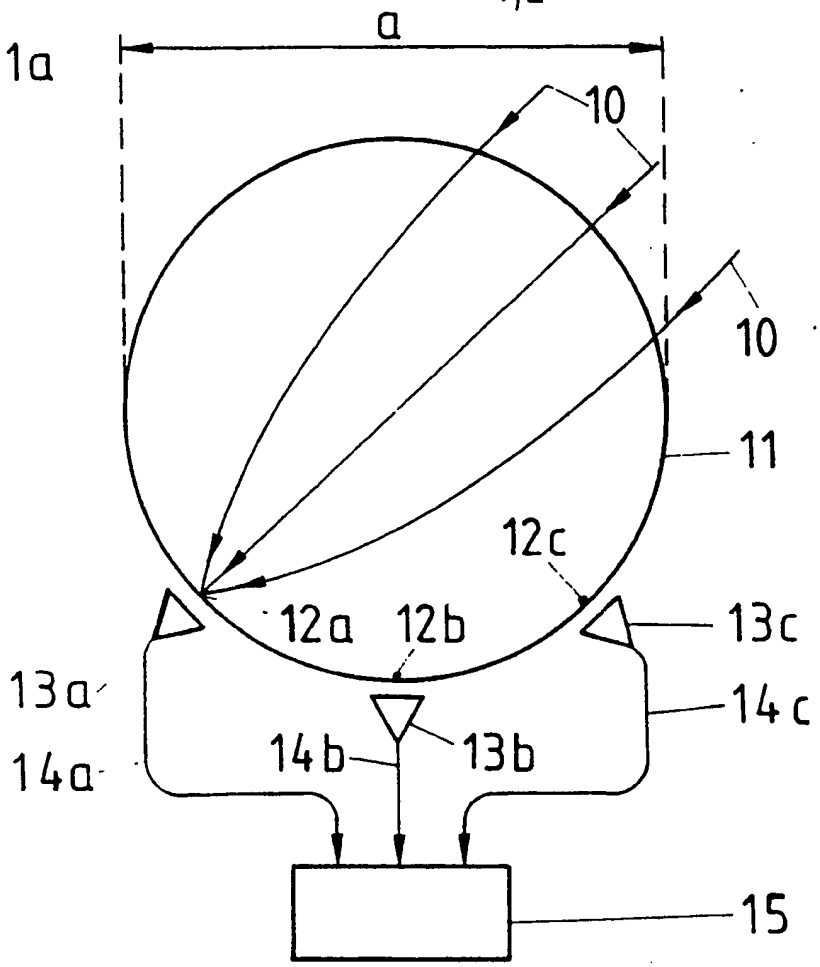

a
10
10
11
12c
12a
12b
13c
13a
14c
14b
13b
14a
15

FIG.1b

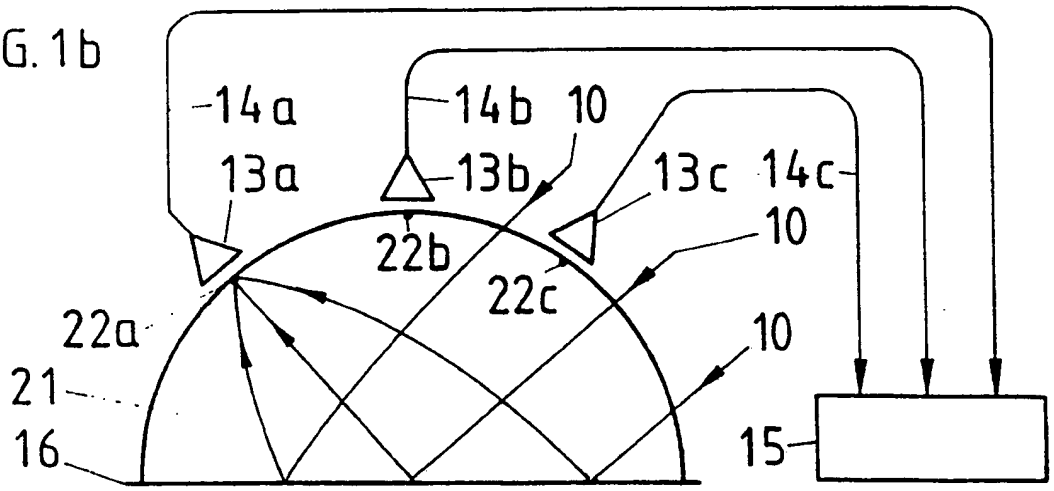

14a
14b
10
13a
13b
13c
14c
10
22b
22c
22a
10
21
16
15

FIG.2

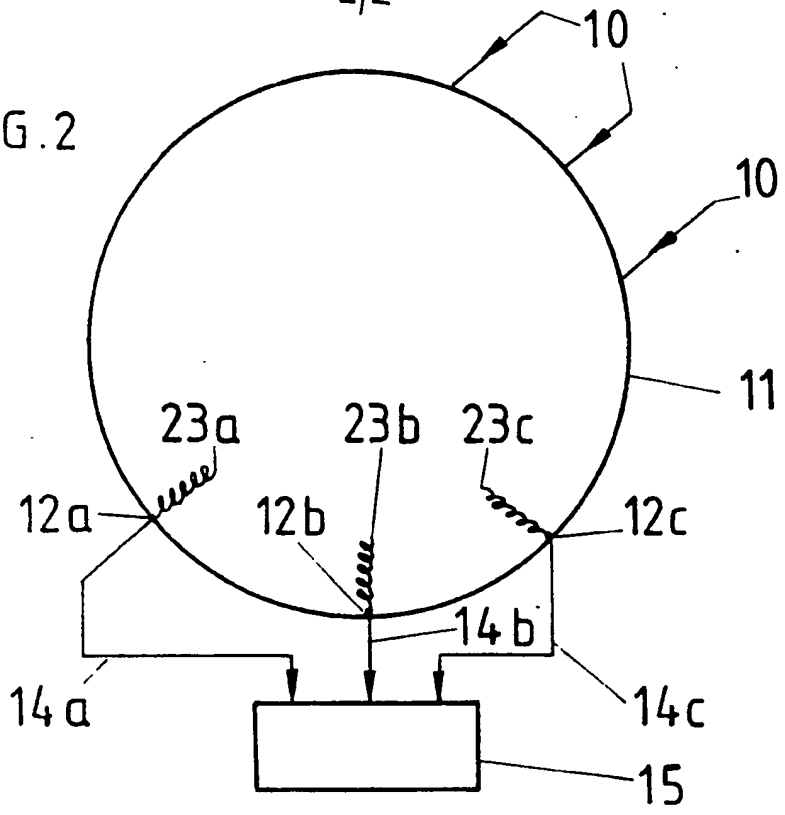
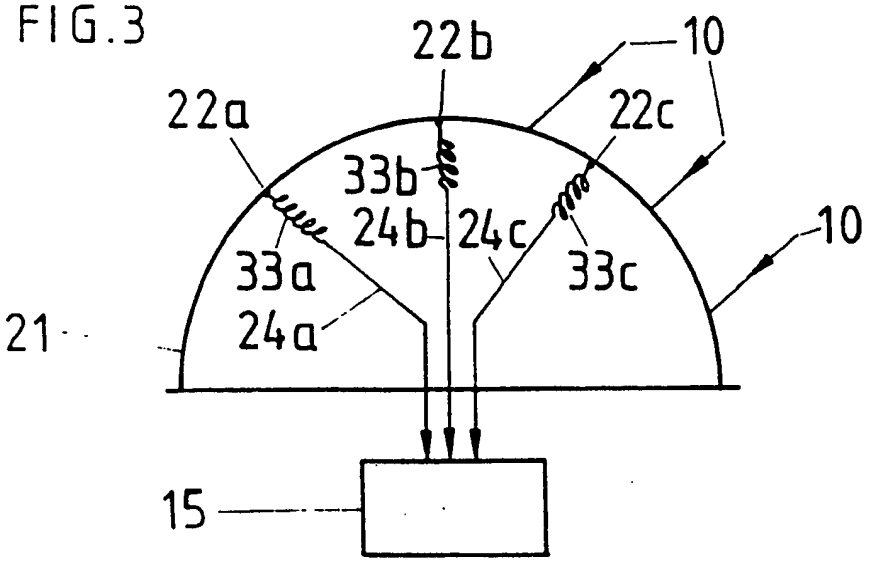

10
10
11
23a
23b
23c
12a
12b
12c
14b
14a
14c
15

FIG.3


22b
10
22a
22c
33b
24b
24c
10
33a
33c
21
24a
15

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 H01Q19/06; H01Q25/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	H01Q

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	US,A,3 487 413 (SHORES) 30 December 1969 see column 4, line 14 - line 20; figures 3,4,8	1-5
X	DE,A,2 849 438 (LICENTIA) 29 May 1980 see page 5, line 27 - page 6, line 29; claims 2,4,5; figures 1,3,5	1-5
X	DE,A,3 134 122 (LICENTIA) 17 March 1983 see page 4, line 9 - line 34; figure	1
A	DE,A,2 738 549 (LICENTIA) 1 March 1979 see page 6, line 23 - page 7, line 8; figure 1A	1-3,5
A	WO,A,8 908 932 (THE SECRETARY OF STATE FOR DEFENCE IN HER BRITANNIC MAJESTY,S GOV.) 21 September 1989 see claims 1-19; figures 4-6	1,5

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
07 APRIL 1992	16.04.92
International Searching Authority	**Signature of Authorized Officer**
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	US,A,4 014 028 (CONE ET AL.) 22 March 1977 see abstract; figure 1	4

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. EP 9200090 SA 55085

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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-3487413	30-12-69	None		
DE-A-2849438	29-05-80	None		
DE-A-3134122	17-03-83	None		
DE-A-2738549	01-03-79	None		
WO-A-8908932	21-09-89	AU-A-	3190689	05-10-89
		GB-A-	2233503	09-01-91
		JP-T-	3502865	27-06-91
US-A-4014028	22-03-77	None		